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C O N F I D E N T I A L TOKYO 13394

FOR OES/NET

ERDA FOR VANDERRYN AND DEMPSEY

E.O. 11652: GDS

TAGS: TECH, JA

SUBJECT: USE OF ALGAE FOR FIRST STAGE HEAVY WATER PRODUCTION

REF: TOKYO A-93, MARCH 16, 1976

1. AFTER MONTHS OF DELAY ON PART OF PROFESSOR ICHIMURA, SCICOUNS WAS ABLE TO VISIT ICHIMURA AT TOYAMA UNIVERSITY. HE WAS ACCOMPANIED BY HEAD OF NSF TOKYO OFFICE, WHO IS BIOLOGIST. REASON FOR DELAY WAS THAT ICHIMURA WANTED TO BE ABLE TO SHOW TWO COMMERCIAL ALGAE PRODUCTION PLANTS IN OPERATION RATHER THAN IN CONSTRUCTION STAGE.

2. ICHIMURA IS IN SCHOOL OF ENGINEERING OF TOYAMA UNIVERSITY, PHYSICALLY LOCATED IN TAKAOKA CITY. MAIN CAMPUS IS IN TOYAMA. HE IS PROFESSOR IN ELECTRONICS DEPARTMENT, TEACHES UNDERGRADUATE COURSES, AND SUPERVISES GRADUATE STUDENTS IN RESEARCH PROJECTS AS PART OF WORK TOWARD M.S. DEGREE. MOST OF HIS GRAD STUDENTS HAVE PROJECTS CONNECTED WITH ELECTRO-OPTICAL DEVICES AND
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COMPONENTS, BUT AVAILABILITY OF MONOCHROMATORS, LIGHT

SOURCES, PHOTOELECTRIC DETECTORS, ETC., OBVIOUSLY OF VALUE IN WORK WITH ALGAE, WHICH IS CONDUCTED IN SAME LAB. EQUIPMENT IS MODERN AND OF HIGH QUALITY.

3. EXPERIMENT WAS IN PROGRESS IN WHICH ABOUT EIGHT FERMEN-TATION FLASKS WERE BEING USED TO MAKE INITIAL CULTURE OF GREEN ALGAE. ORIGINAL SPORES HAD BEEN FOUND IN FIELD NEAR LAB AND HAD BEEN CULTURED ON AGAR PLATES. COLONIES FORMED THERE HAD BEEN TRANSFERRED TO NUTRIENT MEDIUM IN FLASKS. THESE ALGAE ARE CLAIMED TO BE NEW STRAIN IN FAMILY CHLORELLA ELLIPSOIDIA, CHARACTERIZED BY UNUSUALLY RAPID GROWTH RATE--DOUBLING TIME OF EIGHT HOURS COMPARED TO ABOUT 20 HOURS USUALLY EXPERIENCED WITH CHLORELLA.

4. ICHIMURA IS PLANNING TO CONDUCT EXPERIMENTS ON EFFECT OF PRESSURE ON ALGAE GROWTH PROCESSES, SINCE CLOSED CYCLE PRODUCTION PROCESS USED CAN BE ADAPTED TO HIGHER-THAN ATMOSPHERIC PRESSURE AND SINCE ANY PRESSURE EFFECT OBSERVED MAY GIVE CLUES TO MECHANISM OF DEUTERIUM ENRICHMENT IN CELLS. HE ALSO IS PLANNING RESEARCH ON A FILM DIFFUSION PROCESS FOR ENRICHING HEAVY WATER, WITH FILM CONSISTING OF LAYER OF CHLOROPHYLL SUPPORTED ON LAYER OF KEROTENE. FILM WOULD SIMULATE ALGAE CELL WALL. AS PART OF THIS WORK, PHOTOLYSIS OF WATER CATALYZED BY MIXTURE OF CHLOROPHYLL AND ZINC OXIDE WILL BE STUDIED ALSO. (INCIDENTALLY, ICHIMURA HAS NO CAPABILITY TO PERFORM DEUTERIUM ANALYSES; HIS SAMPLES ARE SENT TO PNC FOR THAT PURPOSE).

5. ICHIMURA'S LABORATORY IS STAFFED BY ONE ASSISTANT PROFESSOR, ONE ASSISTANT, AND 10 UNDERGRADUATE AND 5 GRADUATE STUDENTS. HIS RESEARCH STIPEND FROM UNIVERSITY IS YEN 3 MILLION (\$10,000), SUPPLEMENTED BY OCCASIONAL GRANTS FROM OTHER SOURCES. LAST YEAR HE RECEIVED YEN 8 MILLION GRANT FROM MINISTRY OF EDUCATION AND HE HAS HAD FUNDS FROM PNC AS REPORTED PREVIOUSLY. HE IS NOT PERMITTED TO RECEIVE RESEARCH SUPPORT FOR HIS UNIVERSITY RESEARCH FROM PRIVATE INDUSTRY, BUT IS PERMITTED TO ACT AS PAID CONSULTANT TO PRIVATE INDUSTRY. IN THAT CAPACITY HE IS VERY ACTIVE IN HIS RELATIONS WITH TWO PRIVATE COMPANIES IN TAKAOKA AREA WHO ARE OPERATING ALGAE

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PRODUCTION PILOT PLANTS. BOTH PLANTS WERE VISITED.

6. THE LARGEST OF THE TWO FACILITIES IS OWNED BY NIHON CHLORELLA KONPU ("KONPU" IS JAPANESE ACRONYM FOR "CONCENTRATED PROTEIN"). HOUSED IN LARGE SHEET METAL INDUSTRIAL-TYPE BUILDING, THE PLANT CONSISTS OF FIVE 4-TON CAPACITY FERMEN-TATION TANKS MADE FROM FIBERGLAS REINFORCED PLASTIC, TOGETHER WITH ASSOCIATED EQUIPMENT SUCH AS SCREW EXTRACTOR, CENTRI-

FUGE, AND VACUUM DRYER FOR ALGAE. EQUIPMENT APPEARS ALMOST NEW AND THERE WERE NO VISIBLE SIGNS THAT IT WAS IN OPERATION AT TIME OF VISIT. AFTER SOME DISCUSSION WITH PLANT OWNER, VISITORS WERE ALLOWED TO TAKE PHOTOGRAPHS, WITH PROVISIO THAT THEY BE USED FOR U.S. GOVT. PURPOSES ONLY. PRINTS ARE BEING AIRPOUCHED TO OES/NET FOR CIRCULATION TO ERDA AND OTHERS. REASON FOR SECURITY IS THAT COMPANY IS SMALL, HAS REASON TO BELIEVE THAT LARGE JAPANESE CHEMICAL COMPANY MAY TRY TO LEARN ITS TRADE SECRETS, AND THINKS THAT IT WOULD BE UNABLE TO COMPETE WITH LARGE COMPANY IF LATTER ENTERS ALGAE BUSINESS BEFORE SMALL COMPANY HAS FULLY DEVELOPED PROCESS AND ESTABLISHED MARKTS.

7. THIS PLANT IS SAID TO HAVE PRODUCTION CAPACITY OF ABOUT 100 KG OF CHLORELLA PER DAY. PRINCIPLA ECONOMIC INCENTIVE OF PROCESS COMPARED TO OPEN-POND CULTURE IS THAT IT USES CARBON DIOXIDE AT FIVE CENTS PER KG. AS CARBON SOURCE, IN CONTRAST TO ONE DOLLAR PER KG COST OF ACETIC ACID IN JAPAN. OBVIOUSLY CAPITAL COSTS ARE MUCH HIGHER FOR ENCLOSED PROCESS THAN FOR POND CULTIVATION.

8. THE MUCH SMALLER PILOT PLANT OF KUREHA CHEMICAL EQUIPMENT CO. WAS VISITED NEXT. IT IS LOCATED IN HEART OF TOYAMA CITY. ITS FUNCTION HAS NOT BEEN DISCLOSED TO NEIGHBORS FOR FEAR THAT THEY WILL RAISE ENVIRONMENTAL PROTEST, ALTHOUGH NO ODORS OR VISIBLE POLLUTANTS ARE EMITTED. IT HAS A MODEST BUT WELL EQUIPPED LABORATORY STAFFED BY A PROFESSIONAL CHEMIST. FEATURE OF PLANT IS THAT ALL EQUIPMENT IS FABRICATED FROM STAINLESS STEEL, INCLUDING SINGLE FERMENTATION TANK. LATTER IS DOUBLE-WALLED TO PERMIT TEMPERATURE CONTROL BY CIRCULATION OF HEAT TRANSFER FLUID BETWEEN WALLS, WITH IDEA THAT WHEN PROCESS IS SCALED UP, TALL FERMENTATION VESSELS CAN BE CONSTRUCTED WITHOUT

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NEED FOR BUILDING TO HOUSE THEM. ALSO, USE OF STEEL TANK WILL PERMIT OPERATION AT INCREASED PRESSURE, WHICH IS NOT FEASIBLE WITH FIBERGLAS TANKS AT OTHER PLANT. PLANT IS NOT YET IN OPERATION ALTHOUGH ALGAE CULTURES, USING NEW FAST-GROWING STRAIN, ARE BEING GROWN IN LABORATORY TO START UP PLANT. PHOTOGRAPHS WERE AGAIN PERMITTED, WITH SAME PROVISIO. THIS PLANT IS OBVIOUSLY DEVELOPMENTAL IN NATURE, SINCE VACUUM DRYER IS NOT LARGE ENOUGH TO HANDLE OUTPUT OF CULTURING TANK. ANOTHER DIFFERENCE NOTED IS THAT A BASKET CENTRIFUGE IS TO BE USED TO SEPARATE CELLS FROM MEDIUM IN ONE-STEP PROCESS. THERE IS NO SCREW EXTRACTOR.

9. AS FAR AS COULD BE DETERMINED FROM THE SUPERFICIAL INSPECTION OF THE TWO PLANTS, NEITHER ONE IS EQUIPPED TO STORE AND RECYCLE THE CULTURE MEDIUM IN A FASHION THAT

WOULD PERMIT PILOT-SCALE PRODUCTION OF SLIGHTLY ENRICHED HEAVY WATER. THIS COULD BE ACCOMPLISHED WITH MINOR CHANGES IN PIPING AND INSTALLATION OF ADDITIONAL TANKAGE. MORE THAN LIKELY, HEAVY WATER IS NOT ON MINDS OF COMMERCIAL ENTREPRENEURS AT THIS TIME AND THEY MAY NOT EVEN BE AWARE OF THIS POSSIBILITY.

10. AT CONCLUSION OF VISIT, SCICOUNS WAS GIVEN SEVERAL PAPERS ON ALGAE PROCESS BY DR. ICHIMURA. LATEST ONE, AND ONE CONTAINING MOST TECHNICAL DETAIL, HAS BEEN TRANSLATED AND TRANSLATION WILL BE POUCHED TO DEPT. WITH PHOTOGRAPHS NOTED PREVIOUSLY. ALSO BEING POUCHED IS SAMPLE OF CHLORELLA ELLIPSOIDIA FROM PILOT PLANT WHICH WE SUGGEST BE ANALYZED FOR D/H RATIO TO DETERMINE IF ANY DEUTERIUM ENRICHMENT HAS OCCURRED EITHER IN WATER CONTENT OF SAMPLE OR IN ORGANIC MATTER.
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